

## Dengue at the Doorstep: Small Outbreaks in Florida are a Warning Sign to US Navy Medical Personnel

by LT Jen A Wright and LCDR Craig A Stoops

Dengue may not be as well known as malaria as an important human disease transmitted by mosquitoes; however, as climate change possibly spreads pathogens into new territory and the Navy turns its attention to Asia, this may not be the case for much longer. Dengue, also known as Break Bone Fever, is a febrile disease characterized by high fevers, low platelet counts, nausea, vomiting and rash. There are four dengue serotypes and infection with one serotype does not provide protection from the others. In fact, serial infection results in increased likelihood of developing dengue hemorrhagic fever or dengue shock syndrome.

Dengue virus is primarily found in tropic and sub-tropic environments, with over one third of the world's population at risk. The last large outbreak of dengue in US forces occurred during **Operation Restore Hope** in Somalia, where 41 individuals were hospitalized and there was 7% dengue prevalence among a unit of 494 individuals.

Dengue is a daily threat to many Navy sailors, civilians and dependents in areas such as Singapore and Guam. While not many dengue cases have been reported from this area to date, the Navy has experienced negative effects of having sailors stationed in highly endemic areas in the past such as in Puerto Rico and the Philippines. For example, before closing Roosevelt Roads Naval Station, Puerto Rico (PR) in 2004, dengue presented a significant and constant threat to Navy readiness for people living on and around the Naval Station. Dengue

is endemic in PR with isolated outbreaks being reported since 1915 and large island-wide outbreaks since the 1960s. "The mosquitoes would eat you alive at dusk and dengue was a huge problem for the preventative medicine team," said LCDR Jose Medina (ret) MSC USN. "Our preventative medicine teams worked with the locals to provide mosquito surveillance and control, but we were still treating patients for dengue at the Hospital." Since 2004 when the base was closed, outbreaks have continued to occur on the island with over 10,000 cases reported in 2007. With the high amount of travel between the PR and the continental US, it is surprising that outbreaks of dengue haven't occurred with greater frequency. But the lack of cases in the continental US over the last 50 years is believed to be due to infrequent contact between people and the virus' best vector, *Aedes aegypti*.

Along with the resurgence of dengue worldwide, the virus is making a comeback in areas of the continental US. In 2009 the first locally acquired cases of dengue in 50 years occurred in Key West, FL. Given the large presence of US Navy sailors, civilians and dependents at NAS Key West, this outbreak generated great concern. Local dengue transmission reoccurred in Key West during 2010, and in August 2012 locally acquired cases of dengue were reported in Miami-Dade County, FL. Locally acquired cases have since been reported from Palm Beach, Martin, Hillsborough, Osceola and Seminole Counties. In most areas of the world dengue is carried by the yellow fever

mosquito, *Aedes aegypti* and the Asian tiger mosquito, *Ae albopictus*. The yellow fever mosquito is especially effective in transmitting the disease to humans compared to the Asian tiger mosquito, due in part to differences in feeding behavior. *Aedes aegypti* tends to fly around taking small meals from multiple human hosts unlike *Ae albopictus*, which tends to eat one large meal from a single host and it will feed on birds and other mammals in addition to humans. Both species are day biters with peak activity occurring two hours after sunrise and two hours before sunset.

Because both dengue and yellow fever, another mosquito-borne virus, are transmitted by



Figure 1: At the Camp Blanding Joint Training Center, FL, Mr Vincent Smith operates a thermal fogger inside one of the Conex boxes used in the study. Photograph by LT Jen Wright

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Figure 2: At the Camp Blanding Joint Training Center, FL, LT Marcus McDonough examines Asian Tiger mosquitoes during a preliminary joint Army and Navy study evaluating the efficacy of two different mosquito adulticides in sub tropical environments. Photograph by LT Jen Wright

*Ae aegypti*, the history of these two diseases in the US is linked to where *Ae aegypti* was and is currently found. *Aedes aegypti* probably arrived over 300 years ago when it travelled with the first European slave ships from the Caribbean to early settlements such as St Augustine, FL and Charleston, SC. Because *Ae aegypti* was common in many parts of the US, yellow fever and dengue outbreaks were also common, particularly in the south and even during the summer months in northern cities such as Philadelphia, PA. Dengue was first described in the US by Benjamin Rush in 1789 from a victim in Philadelphia, but the history of dengue in the US is a bit murkier, because infections were probably overshadowed by the more deadly and feared yellow fever.

Following the efforts of US Army physician Walter Reed and the Yellow Fever Commission in Cuba during the early part of the 20<sup>th</sup> century, the yellow fever virus was associated with *Ae aegypti* and not due to human contact as it was once believed. Based

on this information, federal, state and local governments dedicated resources to develop and implement mosquito control programs throughout "hot zones" in the United States. These efforts combined with aggressive quarantine and vaccination programs proved to be extremely effective, with the last outbreak of yellow fever occurring in New Orleans in 1905. However, periodic outbreaks would occur. In 1964 the US Government led an *Ae aegypti* eradication effort in Florida, Texas, Puerto Rico and the US Virgin Islands using area-wide application of DDT. Despite the best effort of control teams in the 1960s, *Ae aegypti* proved to be a stubborn foe, with populations remaining in Florida and Texas due to poor control methods, insecticide resistance and reintroduction.

During the 1960s and 1970s, yellow fever vaccination and quarantine was lowering the number of cases worldwide and the risk of acquiring the disease in the US was essentially nonexistent. But failure of *Ae aegypti* eradication efforts left the US

vulnerable to dengue until an unexpected event occurred following the Vietnam war. It is believed that the Asian tiger mosquito was accidentally introduced in tires retrograded from Vietnam, and the species began aggressively replacing the yellow fever mosquito. First recorded in the United States during the 1980s, *Ae albopictus* competes with *Ae aegypti* for the same egg laying habitats. It is thought that this competition may have led to increasing populations and declining *Ae aegypti* populations. The spread of *Ae albopictus* didn't completely eradicate *Ae aegypti* and pockets remained in Key West and along the Texas-Mexico border. And because *Ae albopictus* is a much less efficient vector of the dengue virus, concern around dengue in the continental US waned until the Key West outbreak in 2009.

The Navy Entomology Center of Excellence (NECE) in Jacksonville FL began studying the distribution of *Ae aegypti* and *Ae albopictus* to ascertain the risk of dengue transmission to US Navy personnel in the region following the Key West outbreak in 2011. In the summer of 2012 NECE and Jacksonville Mosquito Control Division (JMCD) teamed up to study where *Ae aegypti* was found in Jacksonville and to determine the population size. The study found significant populations of both species and what was especially surprising was that the population of *Ae aegypti* was much larger than had been anticipated and much larger than the *Ae albopictus* population.

The NECE and JMCD team collected a total of 6,544 *Ae aegypti* and *Ae albopictus* mosquitoes over a ten-week period. *Aedes aegypti* (primary vector of dengue) accounted for 78% and *Ae albopictus* for 17% of the collections. These results were

significant because as of 2010, *Ae aegypti* was believed by the JMCD staff to have been almost replaced by the less potent vector *Ae albopictus*. Because it was believed that *Ae aegypti* populations were low, the risk of locally acquired dengue was considered negligible. But this finding, and the fact that continued local transmission of dengue in Florida has become a yearly occurrence, has changed the equation.

One other positive finding of the study was that the insecticide treatments conducted by JMCD during the study period, as part of their mosquito control program for West Nile virus vectors and other mosquitoes, were extremely effective at lowering the *Ae aegypti* populations. This provides evidence that the Jacksonville *Ae aegypti* population can be controlled using standard mosquito control methods, and if an outbreak were to occur, we wouldn't be helpless. Also, NECE found no apparent insecticide resistance in the Jacksonville *Ae aegypti* to any of the standard insecticides, using the CDC Bottle Bioassay method. Testing for insecticide resistance genes in the population using molecular methods is ongoing.

Dengue cases in Key West served as a "Warning Sign" for sailors and civilians stationed there and across Florida. As locally acquired cases are again a possibility in Key West, and cases slowly creep north towards NAS Pensacola, NAS Jacksonville, NS Mayport and NSB Kings Bay, Navy Medicine personnel should be aware of the risk and be ready to consider dengue as a possibility. Preventive Medicine personnel must also be aware of increases in mosquito populations, especially *Ae aegypti* and *Ae albopictus*, and be ready to implement effective prevention and control programs.



Figure 3: HM2 Michael Denson and LT James Harwood conducting an trial to determine the efficacy of different insecticide formulations from a ULV sprayer and a thermal fogger. Photograph by LT Jen Wright

As there are currently no vaccines available for the disease, avoiding contact with mosquitoes through personal protection methods, such as wearing repellents that contain DEET and wearing a permethrin treated uniform, continue to be the best practices for avoiding infection. However, scientists and physicians at the Naval Medical Research Center in Silver Spring, MD are in the early stages of developing a vaccine through cutting edge research using DNA, with results expected at the end of this year. A second novel approach also being pursued, uses whole virus preparations that have been rendered non-infectious. This latter approach is in the pre-clinical stage of development.

NECE has subject matter experts that provide surveillance and mosquito control and other control strategies against blood-feeding insects that transmit human diseases. This center of mosquito experts provide vector surveillance and control training to civilian and Department of Defense (DoD) technicians who are responsible for ensuring disease vectors are monitored at US DoD installations throughout the world. Additional

guidance on *Ae aegypti* and *Ae albopictus* control can be found in the the "Dengue and Chikungunya Vector Control Pocket Guide" (Technical Guide 47), which can be found on the Armed Forces and Pest Management Board's website at [www.afpmb.org](http://www.afpmb.org). For assistance or information on control of any vector-borne disease contact NECE at [NECE-FleetSupport@med.navy.mil](mailto:NECE-FleetSupport@med.navy.mil).



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